STATISTICAL TOOLS AND TECHNIQUES IN PERSPECTIVE PLANNING IN INDIA

By P. C. MAHALANOBIS

Introduction : The phrase 'perspective planning' is being used in India since about 1954 or 1955 in the field of National Planning in which long range targets have to be set up 10 or 15 or 20 years in advance. The object of the present paper is to explain why perspective planning is essential in the case of under-developed countries and give some illustrative examples of the statistical information and methods which have been found useful for this purpose in India. This is not the occasion to attempt a comprehensive discussion of techniques of perspective planning.

It is useful to make a distinction between projections and targets. The word 'projection', is used in the same way as in advanced countries to refer to the value of production, or of consumption or of other variates, at a specified date in future, estimated on the basis of historical records. Projections are essentially estimates obtained on the basis of analysis of time series or some kind of extrapolation in time. It is convenient to use the word 'target' as the value of production, of consumption, or of other variates of interest. which is desired to be attained on a specified date in future, through the process of implementation of an economic plan. The word 'target' would be used consistently in this sense.

Objects of planning in India : The ultimate objects of planning are to improve the level of living, and expand facilities for education, care of health, cultural amenities etc. for *all* the people of the country. A spectacular improvement in the level of living of the advanced countries has been possible in the past, and a similar improvement would be possible in the less advanced areas in future, only through a continuing increase in the per capita production of *all* the people of the country. Such increase in per capita production can be attained only through a continuing substitution of human and animal power by machines, driven by steam or by electricity, for productive purposes of all kinds including industry, agriculture, transport and distribution.

Changes in the level of living : As our chief concern is with the improvement of the level of living, a continuing National Sample Survey was started in India in 1950 which is collecting comprehensive information on various aspects of the level of living in rural and urban areas with a view to assessing the change over time. The total per capita expenditure per month on all consumer goods and services of each household has been used as a rough indicator of the level of living of the household. The method of fractile graphical analysis[1] has been used to study the distribution by size of total per capita expenditure per month of households. Studies are also being made of the relationship between the total per capita consumer expenditure and the per capita consumption of individual items in terms of money and also in physical quantities where possible.

A study of the distribution of per capita total consumption expenditure by decile groups of households (arranged in ascending order of the total per capita consumer expenditure in each household), shows that for the data collected in the National Sample Survey Round 8 (covering the period July 1954—March 1955), the percentage share of the lowest

1 See 'A method of fractile graphical analysis,' *Econometrica*, **28**, 325-351, 1960; also 'A preliminary note on the consumption of cereals in India,' *Bulletin of the International Statistical Institute*, **39**, 53-76, 1962.

decile group was 3.01 in rural areas and 2.65 in urban areas, and of the second lowest decile group (between the tenth and the twentieth percentiles of households ranked by per capita expenditure) was 4.09 and 3.90 for rural and urban areas respectively. For purposes of perspective planning, four per cent may be used as the share of the second lowest decile group of households.[2]

Targets of planning : The average per capita expenditure in the second lowest decile group was a little over Rs. 10 per month[3] in 1960-61. For purposes of illustration, it is possible to adopt a target of raising, over a period of 15 years, the average per capita consumption expenditure in the second lowest decile group of households from Rs. 10 to Rs. 20 per month (or fifty dollars per capita per year). This amount, at 1960-61 prices, would provide only a very modest level of living in terms of food, clothing and other essential goods or services and amenities.

Doubling the per capita expenditure in fifteen years implies a rate of growth of nearly five per cent per capita per year. It is of interest to note in the present connexion that the per capita income in USA has increased sevenfold in the course of 120 years or at a rate a little over 1.6 per cent per capita per year. A reasonable target of planning in India would thus call for a rate of increase of income at a rate nearly three times greater than the actual rate of increase attained in the USA during the last 120 years. The above comparison would supply a rough idea of the dimension of the efforts required for economic development in India.

For purposes of planning it is necessary to deal with actual figures and not merely in percentages. The population of India is expected to increase to about 650 million compared with about 430 million in 1960. (This, of course, is the population projection for 1975 on plausible assumptions, and not a target ; in fact, if it were possible to bring about a reduction in the rate of growth of population, Indian planners would no doubt adopt a much lower figure as a target). The number of second lowest decile group of households in 1975 would be about 12.5 million on the basis of about five persons per household. To attain a target of Rs. 1,200 (or $ 240) per year per household, the aggregate income of the second lowest decile group of households would have to be Rs. 15,000 million. If it is assumed that this group would still continue to have a four per cent share of the total expenditure of the households[4] then the aggregate national consumption expenditure of households would be 25 times greater or Rs. 375,000 million. The aggregate national income of India in 1975 would have to be somewhat larger to allow for investments and certain other items. The level of national income to be attained in 1975 would have to be somewhat more than double the target of income at the end of Third Five Year Plan in 1966. The rate of growth would have to be about seven per cent per year.

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[2] The lowest decile group has not been used because it may be a somewhat heterogeneous category comprising vagrants, persons living in isolation, tribal people, households in a transient income group etc. many of whom would require special ameliorative measures.

[3] One rupee = 1 shilling 6 pence = 0.21 U. S. cent approximately.

[4] In India the distribution of consumption expenditure of households by size of expenditure has been found to be steady (with some small fluctuations probably due to the effect of changes in prices) over the last ten years. The pattern of distribution of income of households by size of income has also been found generally to change only very slowly over time in most countries of the world. The assumption that the share of the second decile group (or of other fractile groups) of households would remain practically the same in India in 1975 is plausible.

Need of rapid industrialization : Such a rapid change (at a rate three times greater than that of USA) would call for rapid industrial expansion over a period of 15 years.

The ultimate aim is expanding continually the production of consumer goods and services. It is necessary to increase the supply of machinery and energy for this purpose. In India, and in most of the other underdeveloped countries, it is not possible continually to import machinery for production of goods or of fuel on account of shortage of foreign currency. It is essential to establish and expand industries to manufacture machinery, electricals, transport and construction equipment. To increase the capacity for the production of capital goods and energy would be thus the only sound foundation for the expansion of consumer goods and services in future.

At the same time, in all underdeveloped countries it is possible to increase the production of consumer goods with small tools by using traditional methods. This type of production is labour intensive and would give gainful employment to a large number of people who would otherwise remain idle for a good part of their time.

In India a dual strategy was adopted from 1956 in the Second Plan to expand, on one side, the strategic heavy industries for steel, metals, machinery, electricals and chemicals etc. to build up the foundations of industrial progress, and at the same time also to expand the traditional cottage industries and small scale production.

Targets of capital goods : It is therefore necessary to expand and set up not only targets of income or of consumer goods but also of machinery, steel and other metals, electricity, transport, etc. which would be used for the production of the desired volume of consumer goods and services.

Targets of scientific and technical personnel : To achieve the targets of production, it would be necessary rapidly to increase the technical staff to prepare and implement an increasing number of projects. Training facilities must be expanded sufficiently quickly to turn out technical and scientific personnel in adequate numbers at all levels. Scientific and technological research would have to be expanded and oriented to serve the needs of national development in an effective manner. Fundamental research as well as training in research must also be encouraged and developed at the same time to foster the accumulation of basic knowledge and to supply a sound foundation for national decisions being made increasingly on rational grounds.

Balances at the stage of production and utilization : An essential condition for successful planning is to estimate in real terms the requirements of each project to ensure that right quantities of materials, machinery and men are available at the right time at every stage of the implementation of the project. Also, products and services resulting from the completion of each project must be promptly and effectively utilised to promote the execution of other projects and for the progress of the plan as a whole.

The physical targets of production must be balanced in terms of physical quantities of raw materials, machinery, energy, transport etc., and also in terms of man power and of the flow of money. Incomes are generated in the very process of production; and supplies are utilised through market operations. Planning requires that aggregate incomes should be balanced with expenditure, savings should match investments, and the supply and demand of individual goods and services should be balanced in real terms so as to avoid any inflationary rise of prices or undesirable shifts in prices. Physical and financial planning are different aspects of the same reality.

In India a perspective view of development over a long period of years began to be taken from the end of 1954. It was recognised that the targets and the balances of materials and of man power would be only approximate partly for lack of information and partly for defects in organisation and implementation. It was therefore recognised that planning would have to remain flexible and to enable necessary adjustments being made almost continuously. At the same time it was essential to keep in view a wide time horizon of 15 or 20 years or more.

The use of simple models : In 1954-55, some simple models were used to work out the basic strategy of the Second Five Year Plan. The total investment was divided into two parts, one λ_i as the fraction used for investments for the production of capital goods, and the other λ_c as the fraction used for investments for the production of consumer goods ($\lambda_i+\lambda_c = 1$). If the corresponding net output-investment ratios for the production of investment goods and for the production of consumer goods respectively are β_i and β_c then the total net output-investment ratio is $\beta = \lambda_i \beta_i+\lambda_c \beta_c$. By using the following two sector model, and using numerical values for the total investment, and estimated values of β_i and β_c, suitable values of λ_i and λ_c were selected so as to enable the economy to grow at the target rate of five per cent per year or so. In order to estimate the volume of employment, the capital investment required per worker, say θ, was also used.

The growth of national income (Y) in the two sector model is given by the following formula :

$$Y_t = Y_0\left[\ 1+\alpha_0\frac{\lambda_i\beta_i+\lambda_c\beta_c}{\lambda_i\beta_i}\{(1+\lambda_i\beta_i)^t-1\}\ \right]$$

in which Y_0 is the national income in the base year, Y_t the national income in the t-th year, and α_0 the rate of investment in the base year.

On this basis, a Draft Plan-frame for the Second Plan was prepared in March 1955.[5] Values of the different parameters as used in the Draft Plan-frame, the Second Plan (1956-61) as actually realised, and the Third Plan (1961-66) as estimated, are shown in the Table given below.

TABLE (1): INVESTMENT ALLOCATION, CAPITAL PER WORKER AND NET OUTPUT-INVESTMENT RATIO

plan	percentage allocation of investment for		capital per worker (Rs.)	net output-investment ratio		
	investment goods	consumer goods		investment goods	consumer goods	total ($\lambda_i\beta_i+\lambda_c\beta_c$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	λ_i	λ_c	θ	β_i	β_c	β
Second Plan :						
Draft plan-frame (1955)	33	67	5,100	0.20	0.67	0.51
Second plan : actual (1956-61)	36	64	5,400	0.11	0.53	0.38
Third plan : estimate (1961-66)	39	61	6,900	0.21	0.63	0.47

Many changes were made in the targets and allocations of the Draft Plan-frame at the stage of the preparation of the Second Plan; the values of the parameters of the Second Plan as actually realized and the values given in the Draft Plan-frame are therefore not strictly comparable. The interesting point to note is that the estimated parameters for the Third Plan are fairly close to the parameters used in the Draft Plan-frame.

[5] The methods used have been described in 'The approach of operational research to planning in India', *Sankhyā*, **16**, 3-130, 1955.

The rate of investment (α_0) in the first year of the Second Five Year Plan was 9.8 per cent, the initial national income (γ_0) was Rs. 108.0 billion and the values of the other parameters were $\lambda_i = 36\%$, $\lambda_c = 64\%$, $\beta_i = 0{\cdot}11$, $\beta_c = 0.53$, as given in the second row of the above table. Using these values in the above expression, the estimated national income comes out as Rs. 129.7 billion for 1960–61 against an actual figure of Rs. 130.1 billion, both expressed at 1952–53 prices. In the case of the Third Five Year Plan, using the parameters given in the third row of the table, an initial income of Rs. 145.0 billion (at 1960–61 prices) and an initial rate of investment of 11 per cent, the estimated income for 1965–66 on the basis of the two-sector model is Rs. 188.9 billion against an estimate of Rs. 190.0 billion given in the Third Five Year Plan on the basis of detailed sector-wise calculations.

It may be concluded, therefore, that the two-sector model can supply a fairly reliable method for estimating future income. Values of the parameters used for the base period are no doubt subject to errors of estimation ; but this would be true in the case of other methods also. The two sector model gives realistic estimates presumably because it has reasonably correct structural relations between relevant variables.

Values of output-investment ratios : Output-investment ratios β_i and β_c determine, together with the chosen values of λ_i and λ_c and the total amount of investment, the rate of increase of income and have an important role in planning. These two coefficients of net output-investment ratios were calculated from technological and statistical information in respect of hundreds of enterprizes combined with appropriate weights. The calculated values for manufacturing industries are given in Table (A 1).

Need of perspective planning : Steel : The need of looking a long way ahead was learnt in India through experience. I shall give one example. In 1949 when preparatory work had just started for the First Five Year Plan, a decision was practically reached to increase the capacity for the production of steel from a little less than one million ton per year to two million tons per year in the course of five years. However, a careful survey was made of the current demand as in 1949. It was found that the maximum demand would be about 1.5 million ton per year. With marginal expansion of existing steel plants, it was possible to produce about a million ton per year within the country. Owing to the wide prevalence of the views of short-range economic theory, it was therefore decided that it would be inadvisable to include a new million ton steel plant in the First Five Year Plan of India.

In consequence, great difficulties began to be experienced from the early years of the First Plan. Practically all the estimates for investments had been made in purely financial terms and a sizable increase in investments had been approved purely on a financial basis. As soon as the investment projects began to be implemented, there was a sharp and continuing increase in the requirements of steel and other goods and services. Very soon the demand for cement increased to nearly three times the domestic supply. There was also a continuing and large expenditure of foreign currency for the import of steel, which added up to something like 2,000 million dollars in the next ten years or so. In 1950 it would have been possible to establish a new million ton steel plant with perhaps about 150 million dollars of imported machinery. Had this project been started at that time an additional supply of one million ton of steel (worth more than one hundred million dollars per year) would have been available from the early years of the

Second Five Year Plan, and would have resulted in a very large and continuing saving of foreign exchange. The decision to drop the million ton steel project from the First Plan was due to attention being focussed only on the current demand in 1949, that is, due to a complete failure to appreciate the need of looking ahead to get ready to meet the demand for steel which was certain to increase rapidly in future.

Targets of steel in 1970 : At heavy cost we had learnt the lesson of not proceeding with the building up of capacity for steel production 12 or 15 years ago. Much attention is now being given to advance planning for steel. A detailed analysis of the requirements of steel is made, where possible, by individual items of production. With a given set of production targets for, say, 1970, it is possible in this way to prepare useful estimates of the requirements of steel. Some illustrative figures for the transport equipment industry is given in the following table.

TABLE (2): STEEL REQUIREMENTS FOR TRANSPORT EQUIPMENT INDUSTRY IN 1970

	industries	production target in 1970	tons of rolled steel required per unit of output	steel requirement in 1970 (in thousand tons)
	(1)	(2)	(3)	(4)
1.	steam locomotives	300	150	45.0
2.	electric „	150	55	8.3
3.	diesel „	200	55	11.0
4.	wagons	40,000	12	480.0
5.	passenger coaches	2,500	30	75.0
6.	automobiles	180,000	2.9	522.0
7.	motor cycles, scooters	150,000	0.1	15.0
8.	bicycles	4,000,000	0.02	80.0
9.	ships (GRT)	160,000	0.65	104.0

Source : Demand for steel, special steel and pig iron. India : 1960—1970 : Perspective Planning Division, Planning Commission.

The transport equipment industry would thus require about 1.34 million ton of steel per year. Requirements of other industries were estimated in the same way; the grand total for industries came to about 8 million tons of rolled metal.

In other cases a different approach is necessary. The steel requirement per rupee of net investment has been estimated for different types of activities. For example, the consumption of steel is 40 tons per investment of Rs. 100,000 in railways; the corresponding figure is so low as only 5 tons in large and medium scale irrigation. The total steel requirement for a target of investment in the Fourth Plan amounting to Rs. 170,000 million can be estimated at 20 or 21 million tons.

Also, on the basis of the investment outlay for the last year of the Fourth Plan, one can estimate the steel requirement at about 5 million tons at the end of the Fourth Plan. Adding to this the current requirement of 8 million tons for industries, the total demand would be about 13 million tons of steel in 1970-71. In the same way it has been estimated that the requirement of steel would reach 18 or 19 million tons in 1975.

Balance of electricity : It is possible in the same way to estimate the requirements of electricity from the physical targets of production for any given year. For example, the production of ferro-manganese in 1960-61 was 100,000 tons for which the electricity consumed was 500 million kwh. For a target production of 385,000 tons for ferro-manganese in 1970-71, the requirements of electricity would be 1,952 million kwh. A similar method of calculation was used for different types of industries. Table (A-3) in the Appendix gives the details. Steel and electricity are typical illustrations of the material balances which have been prepared in India for important commodities and energy for perspective planning of the economy 15 or 20 years ahead.

Perspective planning of fertilisers : The population of India is growing roughly at the rate of perhaps 9 million per year. The additional quantity of food grains required for these 9 million people would be about 1.5 million tons a year. This would add up to 22.5 million tons in the first five year period (not to speak of 60 million tons in the second five year period). At an average price of 90 dollars per ton, the cost of importing 22.5 million tons in a five year period would come to about 2,000 million dollars.

On the other hand, if imported ammonium sulphate is used, each ton on an average should increase the yield of food grains by about 2.2 tons. On this basis, roughly 10 million tons of imported ammonium sulphate would enable the domestic production of food grains being increased by about 22 million tons in a five year period. At an average price of 70 dollars per ton of fertilisers, the cost in foreign currency would be only about 700 million dollars or a third of the cost of imported food grains.

Imported foodgrains can be quickly distributed and it is possible to make necessary arrangements for such imports at short notice in the course of a year or so under normal conditions of easy availability of foodgrains in the world market. (The lack of foreign currency is the only limitation in a country like India). The import of fertilisers, however, require placing of orders a year or two or even more years in advance because the supply position is not so easy as in the case of foodgrains. Such a plan would, therefore, require taking a view of future needs two or three years ahead.

A third possibility would be to set up a new factory every year for the production of 750,000 tons of ammonium sulphate per year. At the cost of about 90 million dollars for each factory, the total expenditure would come to 450 million dollars of which, however, only 250 million dollars would be the foreign exchange requirement. The setting up of a new fertiliser factory would require at least five or six years; the process of planning must therefore start something like 10 years in advance.

Finally, it is also possible to manufacture in India machinery for the installation every year of a new fertilizer factory with capacity to produce 750,000 tons of ammonium sulphate per year. The foreign exchange requirement for this purpose would be less than 100 dollars, to be spent once and for all. However, the installation of a plant to manufacture machinery for the production of fertilisers would take at least five or six years. When the first batch of machinery is produced, it would take another five years or so to complete the construction of a fertiliser factory. Such a plan would require a view being taken of future requirements at least 12 or 15 years in advance.

Consumer goods : In the case of consumer goods the increase in demand is estimated on the basis of the increase of income accepted as a target. Standard methods are used

to calculate the elasticity of demand from information regarding expenditure (and consumption in physical terms, where possible) of a large number of commodities and services which is being collected every year by the National Sample Survey (NSS) of India. In the NSS, the design of interpenetrating net-work of sub-samples (IPNS) is always used providing at least two independent estimates of each variate. It is, therefore, possible to estimate the elasticity of demand on the basis of each sub-sample and also on the basis of the combined sample of the two sub-samples pooled together. Table (A-2) in the Appendix gives estimates of percentage increases in demand over the five-year period of the Third Plan. The two independent sub-sample estimates supply useful information on the margin of uncertainty of the estimates.

In a planned economy it is not possible to allow the supply to increase with the demand without any restriction. It is necessary to increase domestic savings by restricting the consumption of non-essential or luxury goods. It is therefore necessary to impose excise and sales tax or controls on imports or on production to bring about a balance between the planned supply and the estimated demand.

Recently the method of fractile graphical analysis is being used for estimating elasticities of demand for households having different values of total per capita consumer expenditure (which is a rough indicator of the level of living). This approach has the great advantage of showing, in a very simple way, the pattern of change of the elasticity of demand with a change in the level of living. Analysis by fractile groups is particularly useful in studying the effect of excise and sales tax in balancing supply and demand.

Perspective planning of man-power: It is only with the help of skilled workers, technicians, technologists and engineers that raw materials can be converted into machinery, electricity and power which can then be used for the production of both capital and consumer goods. A rapidly increasing supply of engineers and technical personnel is essential for economic development. It is necessary to establish and broaden the base of primary and secondary education and to establish technical and scientific institutions and increase their number rapidly. The most serious difficulty is the lack of trained and experienced teachers at all levels. To build up a sound foundation for the outturn of technical personnel would take a great deal of time; it is a much more slowly maturing process than establishing heavy machine building, steel, heavy electrical or heavy chemical industries. Perspective planning is indispensable, and it is necessary to have targets twenty years or more in advance.

Scientific and technical manpower: From about 1955 a great deal of attention is being given in India to the question of technical manpower. The method used for estimating the requirements of technical personnel is simple and straightforward. Information relating to manufacturing industries for the reference period 1956 was collected as a part of the National Sample Surveys and was analysed in detail to ascertain the number of professional and technical workers (including engineers and scientists) employed in manufacturing industries. Estimates for a number of selected industries are given in Table 3 in the form of percentages of total employment (that is, number of engaged persons) in different industries. Separate figures are given in col. (2) for the proportion of professional, technical and associated workers taken together, in col. (3) for the proportion of engineers, architects and surveyors, and in col. (4) for the proportion of scientists including chemists, physicists, geologists and other physical scientists.

There are wide variations in requirements of professional and technical personnel or of engineers or scientists from one industry to another. In chemicals, and aircraft

assembling and repair, the proportion of professional and technical staff is about 10 per cent. The chemical industries, naturally, require 5 per cent of scientists (no doubt, mostly chemists) and only 0.6 per cent of engineers. In contrast, aircraft assembling and repair requires a high proportion of about 5.5 per cent of engineers but practically no scientists.

TABLE (3): TECHNICAL PERSONNEL IN SELECTED INDUSTRIES : SAMPLE SURVEY OF MANUFACTURING INDUSTRIES, 1956

industries	percentage of total employment		
	professional	engineers	scientists
(1)	(2)	(3)	(4)
1. rice milling	0.87	0.08	0.00
2. cotton textiles	0.90	0.12	0.51
3. glass and glassware	0.99	0.19	0.18
4. tea manufacturing	2.39	0.31	0.03
5. aluminium, copper, brass : secondary products	2.49	1.58	0.05
6. sugar	2.65	0.51	0.71
7. general engineering and electrical engineering	4.27	2.02	0.01
8. paints and varnishes	5.44	0.31	3.47
9. cement	5.53	0.89	1.12
10. petroleum refining	5.56	1.55	2.40
11. electricity generation and transmission	6.50	4.79	0.04
12. iron and steel : primary products	6.70	2.86	0.58
13. railway wagon manufacturing	8.46	3.02	0.21
14. aircraft assembling and repair	9.93	5.47	0.00
15. chemicals (including drugs)	9.99	0.62	5.06

Source : *Occupational Pattern in Manufacturing Industries, India 1956* by Pitambar Pant and M. Vasudevan with a foreword by P. C. Mahalanobis. Planning Commission, Government of India, 1959. In col. (2) 'professional' stands for all professional, technical and related workers. In col. (3) 'engineers' cover architects and surveyors. In col. (4) 'scientists' stand for chemists, physicists, geologists and other physical scientists.

With any assumed target of production for any particular industry in any given year, it is possible to estimate the total number of engaged persons and hence the number of professional staff, engineers and scientists. Requirements of engineers and technical personnel were estimated in this way for purposes of perspective planning.

Expansion of technical staff : Appropriate action was taken to expand the capacity of existing scientific and technological institutions and to establish new institutions all over the country to ensure a sufficiently rapid expansion of scientific and technical personnel. The following table shows the new admissions into universities and higher educational institutions of the university standard in science and technology.

TABLE (4): ADMISSIONS INTO HIGHER DEGREE LEVEL INSTITUTIONS IN SCIENCE AND TECHNOLOGY

subject	1950-51	1960-61	1965-66	1975-76	1950-51	1960-61	1965-66	1975-76
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	in thousands				as percentage of 1950-51 figures			
1. science	51	116	199	264	100	227	390	518
2. engineering	4	14	25	70	100	350	625	1,750
3. medicine	2.5	6	8	20	100	240	320	800
4. agriculture	2.0	5	9	15	100	250	450	750
5. total	59.5	141	241	369	100	237	405	620

On the whole the planning for scientific and technical manpower, particularly for engineering, has been quite satisfactory in India. For example, the new admissions in engineering increased from 4,000 a year in 1950-51 to 14,000 a year in 1960-61. Also, the target is about 25,000 new admissions in 1965-66, and 70,000 in 1975-76.

Outturn of engineers: The Appendix Table (A-4) gives the outturn of scientists and engineers in India from 1915 to 1960. It would be seen from Table (A-4), line 8 and col. (4), that the number of degree level engineers turned out between 1915 and 1947 was 14,984 in 33 years before independence. This was practically matched by a turnout of 14,385 in five years during the period of the First Plan (1951–56). The outturn increased much further to 24,166 during the five-year period of the Second Plan.

The outturn for individual years between 1951 and 1960 also shows a very rapid increase. The outturn of degree level engineers was 1,700 in 1951 which was nearly doubled in three or four years. Perspective planning of technical personnel was seriously started from 1955; the effect became visible after four years in 1959 when the outturn rose to 6,779 against 3,689 in the previous year, that is, an increase of more than three thousand in one year.

Scientific Research. Although the intake and outturn of scientists also has been increasing fairly rapidly, I am sorry to say that perspective planning of scientific research has not yet started seriously. The emergence into the modern age of any underdeveloped country would be possible only with the building of the base of science education and scientific research. Certain compelling reasons can be appreciated very easily. Natural resources are not identical everywhere; there are wide variations from one country to another. Resources available within any country can be used most effectively only through continuing applied scientific and technological research in which use is made of basic scientific knowledge to solve practical problems. It is also necessary to provide facilities for fundamental research not only for the accumulation of scientific knowledge but also to supply scientists who would be able to diagnose problems properly and identify how such problems should be handled or what kind of help should be obtained from abroad. There is also a deeper need of replacing the traditional pattern of making decisions on the basis of authority by decisions to be made increasingly on objective grounds based on scientific and rational thinking.

Perspective planning is indispensable. The need of perspective planning, especially in underdeveloped countries, may be stated very briefly in conclusion. It is necessary to increase the supply of consumer goods. To do this it is necessary to expand continually the production of capital goods. Both would require an increasing supply of engineers and technicians. Industrial and technological developments would call for a rapid expansion of applied research which, in its turn, would require a sound foundation of basic research.

The factor of time may be next considered. Factories for the production of practically of any kind of consumer goods can be established in a year or two with the help of imported machinery or fuel. To develop the production of capital goods and energy would take it at least 10 or 15 years. To secure an adequate supply of engineering and technical personnel would require 20 or 25 years. To have enough scientists of ability for both applied and basic research would take at least a generation or even more. It is clear that perspective planning, looking 15 or 20 or 30 years ahead, is indispensable for all underdeveloped countries

Appendix

TABLE (A-1): ESTIMATES OF β AND θ FOR MAJOR GROUPS OF MANUFACTURING INDUSTRIES WITH 1957 AND 1960-61 WEIGHTS

		β		θ (thousand Rs.)	
		1957 weights	1960-61 weights	1957 weights	1960-61 weights
	(1)	(2)	(3)	(4)	(5)
1.	metallurgical industries :	0.19	0.20	178.9	172.3
2.	,, : semi manf.	0.47	0.45	17.1	19.0
3.	mechanical and general engineering	0.66	0.65	11.4	10.9
4.	transport equipment	0.45	0.45	15.4	15.3
5.	electrical equipment	0.50	0.49	16.6	18.5
6.	industrial machinery (I)	0.62	0.61	24.9	22.7
7.	,, ,, (II)	0.47	0.43	17.4	20.1
8.	chemicals	0.35	0.32	29.1	30.3
9.	textiles	0.38	0.38	10.6	10.5
10.	rubber and leather products	0.62	0.61	14.5	14.8
11.	food industries	0.30	0.30	13.0	12.9
12.	mining industries	0.33	0.35	17.6	20.5
13.	timber and cellulose industries	0.33	0.31	11.2	12.3
14.	mining and oil industry	0.43	0.39	9.5	11.1
15.	all industries	0.36	0.35	13.2	15.3

Note : The coefficients are obtained from detailed industry-wise information compiled by the Perspective Planning Division of the Planning Commission in collaboration with the Planning Unit of the Indian Statistical Institute.

TABLE (A-2): ESTIMATES OF PERCENTAGE INCREASES IN DEMAND OVER THE THIRD FIVE YEAR PLAN PERIOD 1961–1966

		percentage increase in demand								
	name of item	urban India			rural India			all-India		
		ss. 1	ss. 2	com-bined	ss. 1	ss. 2	com-bined	ss. 1	ss. 2	com-bined
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	pulses	32	32	32	19	21	20	21	23	22
2.	vegetables	35	38	36	22	23	22	26	27	26
3.	spices	30	31	30	18	17	17	19	20	19
4.	edible oil	35	35	35	23	20	22	26	24	25
5.	sugar	38	39	38	29	28	29	31	31	31
6.	milk and milk products	46	43	44	33	40	36	37	40	38
7.	meat, fish, eggs	38	40	39	21	21	21	26	28	27
8.	fruits and nuts	46	45	45	23	25	24	32	33	32
9.	beverage and refreshments	42	41	41	28	27	27	34	34	34
10.	tobacco	36	35	36	22	19	21	25	23	24
11.	kerosene	32	33	32	19	18	19	22	22	22
12.	fuel and light	33	33	33	19	17	18	22	21	21
13.	cotton clothing (mill-made)	49	43	48	36	33	34	39	35	37
14.	washing soap	38	39	39	30	27	30	33	32	33
15.	toilets	45	41	41	22	22	22	32	30	30
16.	railway	53	49	53	46	33	35	49	40	43
17.	conveyance	53	55	53	38	28	35	44	39	43
18.	cinema	45	53	49	32	30	31	41	44	42
19.	domestic utensils	31	46	37	37	23	36	37	26	36

Note : Based on elasticities calculated in the Indian Statistical Institute, Calcutta from 10th round NSS data relating to December 1955–May 1956.

TABLE (A-3): ELECTRICITY BALANCE

consuming industry	unit	volume of production			electricity consumption in m.kwh			electricity consumption per unit of production
		1960-61 production	1965-66 capacity	1970-71 capacity	1960-61	1965-66	1970-71	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. iron and steel								
1 finished steel	m. ton	2.2	7.5	13.5	1,100	3,750	6,750	500 kwh/ton
2 pig iron	,,	0.9	1.5	3.0	18	30	60	20 ,,
3 steel re-rolling					200	550		
2. ferro-manganese	000 tons	100.0	220.0	385.0	500	1,100	1,925	5,000 ,,
3. ferro-silicon	,,	6.0	40.0	60.0	48	320	480	8,000 ,,
4. alloy steel	,,	—	200.0	500.0	—	250	625	1,250 ,,
5. aluminium	,,	18.5	125.0	250.0	370	2,500	5,000	20,000 ,,
6. copper	,,	8.9	22.0	50.0	27	66	150	3,000 ,,
7. zinc	,,	3.2	15.0	30.0	13	63	126	4,200 ,,
8. coal								
1 bituminous	m. ton	53.0	97.0	180.0	106	1,940	3,600	20 ,,
2 brown	,,	—	6.0	12.0	—	120	240	20 ,,
9. petroleum (refining)	,,	4.6	17.0	30.0	161	595	1,050	35 ,,
10. fertilizers								
1 nitrogeneous, electrolytic process	000 tons	110.0	80.0	80.0	462	1,280	1,280	16,000 ,,
2 ,, , rest	,,	—	920.0	1,920.0	—	3,864	8,064	4,200 ,,
3 phosphatic	,,	55.0	500.0	1,250.0	25	225	563	450 ,,
11. heavy chemicals								
1 sulfuric acid	,,	363.0	1,750.0	3,700.0	91	438	925	250 ,,
2 soda ash	,,	145.0	530.0	860.0	22	80	129	150 ,,
3 caustic soda, chemical process	,,	—	50.0	90.0	—	25	45	500 ,,
4 caustic soda, electrolytic process	,,	100.0	350.0	610.0	420	1,470	2,562	4,200 ,,
12. plastics	,,	10.0	85.0	250.0	1	5	15	60 ,,
13. soap	,,	150.0	500.0	700.0	30	100	140	200 ,,
14. synthetic rubber	,,	—	50.0	140.0	—	35	98	700 ,,
15. paper and paper board	,,	350.0	820.0	1,500.0	630	1,476	2,775	1,800 ,,
16. newsprint and security paper	,,	25.0	151.5	240.0	16	98	156	650 ,,

Notes : *Source :* Perspective Planning Division paper: Demand for Electricity, India 1960–1970. The table covers all industrial uses of electricity. The norms of electricity requirement in different industries, given in col. (9), have been used to work out the consumption of electricity in 1960-61, 1965-66 and 1970-71 given respectively in cols. (6), (7) and (8).

TABLE (A-3): ELECTRICITY BALANCE—*Contd.*

consuming industry	unit	volume of production			electricity consumption in m.kwh			electricity consumption per unit of production
		1960-61 production	1965-66 capacity	1970-71 capacity	1960-61	1965-66	1970-71	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
17. cement	m. tons	8.0	15.0	26.0	960	1,800	3,120	120 kwh/ton
18. cotton textiles	m. metres	4,572.0	5,300.0	6,400.0	1,998	2,316	2,797	437 kwh/000 metres
19. jute	000 tons	1,065.0	1,200.0	1,600.0	415	468	624	390 kwh/ton
20. rayon and staple fibre								
1 rayon filament	m.lbs.	47.0	140.0	250.0	147	438	781	3,125 kwh/000 lbs.
2 staple fibre	,,	47.8	75.0	120.0	40	62	99	825 ,,
3 chemical pulp	000 tons	—	120.0	250.0	—	60	125	500 kwh/ton
21. woollen fabrics-yarn	m. lbs.	28.0	67.0	100.0	84	201	300	3,000 kwh/000 lbs.
22. silk	m. yds.	350.0	550.0	800.0	105	165	240	300 kwh/000 yards
23. sugar	m. tons	2.7	3.5	4.5	162	210	270	60 kwh/ton
24. vegetable oil	,,	0.8	1.2	2.2	100	150	275	125 ,,
25. vanaspati ghee	000 tons	330.0	550.0	730.0	73	121	161	220 ,,
26. bicycles	m. nos.	1.0	2.2	3.5	15	33	53	15 kwh/nos.
27. sewing machines	000 nos.	300.0	700.0	1,200.0	18	42	72	60 kwh/nos.
28. electric fans	m. nos.	0.9	2.8	4.5	18	56	90	20 kwh/nos.
29. electric lamps	,,	39.5	83.0	120.0	6	12	18	150 kwg/000 nos.
30. matches	m. gross boxes	33.0	45.0	52.0	20	27	31	600 kwh/000 gross boxes
31. plywood	m. sq. metre	15.5	27.0	45.0	14	25	42	930 kwh/000 sq. metres
32. calcium carbide	000 tons	10.0	67.0	110.0	35	235	385	3,500 kwh/ton
33. automobile tyres	m. nos.	1.4	3.7	7.5	150	396	803	107 kwh/nos.
34. automobiles	000 nos.	53.5	100.0	200.0	54	100	200	1,000 kwh/nos.
35. coke	m. tons	5.0	15.0	25.0	125	375	625	25 kwh/ton
36. total					8779	27672	47870	

Notes: *Source*: Perspective Planning Division paper: Demand for Electricity, India 1960–1970. The table covers all industrial uses of electricity. The norms of electricity requirement in different industries, given in col. (9), have been used to work out the consumption of electricity in 1960-61, 1965-66 and 1970-71 given respectively in cols. (6), (7) and (8).

TABLE (A-4): OUTTURN OF SCIENTISTS AND ENGINEERS IN INDIA

	year	number of persons graduating					
		master's degree in natural science		engineering			
		total	average per year	degree	diploma	total	average per year
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	1915–19	832	166	568	1,703	2,271	454
2.	1920–24	917	183	771	1,902	2,673	535
3.	1925–29	1,923	385	1,619	4,322	5,941	1,188
4.	1930–34	2,784	557	2,190	5,397	7,587	1,517
5.	1935–39	2,938	588	2,901	5,331	8,232	1,646
6.	1940–44	3,378	676	3,765	6,280	10,045	2,009
7.	1945–47	2,511	837	3,170	4,538	7,708	2,569
8.	1915–47	15,283	463	14,984	29,473	44,457	1,347
9.	1948–50	2,947	982	4,691	4,623	9,314	3,105
10.	1951–55 (1st Plan)	9,062	1,812	14,385	11,629	26,014	5,203
11.	1956–61 (2nd Plan)	15,799	3,160	24,166	27,037	51,203	10,241
12.	1951	1,409	1,409	2,301	1,700	4,001	4,001
13.	1952	1,680	1,680	2,559	2,049	4,608	4,608
14.	1953	1,694	1,694	2,926	1,693	4,619	4,619
15.	1954	2,068	2,068	3,238	2,833	6,071	6,071
16.	1955	2,211	2,211	3,361	3,354	6,715	6,715
17.	1956	2,456	2,456	3,456	4,131	7,587	7,587
18.	1957	2,832	2,832	3,507	4,413	7,920	7,920
19.	1958	2,982	2,982	3,689	5,944	9,633	9,633
20.	1959	3,558	3,558	6,779	6,182	12,961	12,961
21.	1960	3,971	3,971	6,735	6,367	13,102	13,102

Note: Figures are taken from 'Recent developments in the organization of science in India' by P. C. Mahalanobis; 'Engineers in India' by Scientific and Technical Manpower Division, Planning Commission; 'Education in India' by Ministry of Education, and also direct information from the Resources & Scientific Research Division of the Planning Commission.

TABLE (A-5) : AVERAGE PER CAPITA CONSUMER EXPENDITURE IN RUPEES PER MONTH (30 DAYS), PERCENTAGE SHARE OF TOTAL CONSUMER EXPENDITURE AND LIMITING VALUES OF CONSUMER EXPENDITURE BY FRACTILE GROUPS FOR THE 8TH ROUND OF THE NATIONAL SAMPLE SURVEY, JULY 1954—MARCH 1955, ALL-INDIA : RURAL AND URBAN

fractile group (percentage)		average per capita consumer expenditure (Rs.)						percentage share						limiting values (Rs.)					
		rural			urban			rural			urban			rural			urban		
		ss. 1	ss. 2	pooled	ss. 1	ss. 2	pooled	ss. 1	ss. 2	pooled	ss. 1	ss. 2	pooled	ss. 1	ss. 2	pooled	ss. 1	ss. 2	pooled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1.	lowest	—	—	—	—	—	—	—	—	—	—	—	—	2.19	2.20	2.19	2.76	2.43	2.43
2.	0— 10	4.21	4.64	4.48	6.20	6.68	6.54	2.75	3.03	3.01	2.96	2.46	2.65	5.48	5.89	5.70	8.14	8.52	8.30
3.	10— 20	6.25	6.56	42	9.30	9.96	9.59	4.07	4.41	4.09	4.27	3.48	3.90	7.01	7.39	7.18	10.22	11.24	10.82
4.	10— 30	7.72	8.24	7.99	11.62	12.83	12.06	5.05	5.57	5.33	4.56	4.72	4.86	8.26	8.93	8.67	12.68	14.02	13.29
5.	30— 40	9.26	9.52	9.37	13.75	15.19	14.28	6.11	6.19	6.18	6.73	5.34	5.70	10.15	10.18	10.17	14.65	16.91	15.30
6.	40— 50	10.91	10.89	10.90	16.00	18.56	16.94	7.18	7.43	7.27	7.05	6.86	6.78	11.74	11.75	11.74	17.42	20.17	18.50
7.	50— 60	12.61	12.65	12.63	19.00	21.62	20.11	8.27	8.35	8.35	8.29	7.82	8.01	13.73	13.70	13.73	20.91	23.79	21.73
8.	60— 70	14.82	15.12	14.94	22.68	26.82	23.86	9.51	10.00	9.74	9.98	9.71	9.64	16.23	16.69	16.42	24.45	29.65	26.08
9.	70— 80	17.72	18.54	18.17	27.20	33.52	29.52	11.78	12.23	11.95	11.65	12.16	11.86	19.72	20.83	20.22	30.92	37.20	33.48
10.	80— 90	22.42	23.80	23.04	37.56	43.54	39.00	14.78	16.18	15.53	15.43	15.78	15.61	26.79	28.03	27.55	46.71	53.61	46.65
11.	90—100	46.44	39.00	42.16	65.20	88.22	76.78	30.50	26.61	28.55	29.08	31.67	30.99	239.25	112.96	239.25	525.07	333.92	525.07
12.	0—100	14.93	14.98	14.96	22.44	27.69	25.24	100.00	100.00	100.00	100.00	100.00	100.00	239.25	112.96	239.25	525.07	333.92	525.07
13.	number of villages or blocks	353	353	706	238	228	466	353	353	706	238	228	466	353	353	706	238	228	466
14.	number of households	931	938	1869	963	892	1855	931	938	1869	963	892	1855	931	938	1869	963	892	1855

Source : Indian Statistical Institute, Calcutta.